LESSONS WE NEVER LEARN

Using the Work of
Richard Fox
John O'Brien
Larry Ross
Jack Lee
Richard Reeves
And Others

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THE STORY

- High Costs, Caused by NASA's MANAGEMENT CULTURE, ARE IN THE WAY OF DOING GREAT PROGRAMS!

- Large cost reductions can only be accomplished by MAJOR cultural changes in the way NASA manages programs

- Attempts at Management Reform Have FAILED because of cultural resistance to change

- Cost Reductions have nearly always taken the form of removing program content: this is unnecessary, risky, and counterproductive (e.g., removing testing to save money)

- NASA Management Studies have found several major themes for why costs are so high (Fox et. al.)

  - The learning of a lesson is NOT ENOUGH to effect a change. Cultural resistance has prevented meaningful change!

  - How we contract has the largest cost leverage (incentives, requirements, changes)

  - Management of "Manned" programs is very inefficient

  - Programs should only begin when there is a balance between requirements, technical readiness, schedules, and budget availability

- MANAGEMENT REFORMS HAVE BEEN ADOPTED (SEI)

- SOME LESSONS, SUCCESSFULLY IMPLEMENTED, HAVE BEEN "UN-LEARNED" because of cultural "Spring-back"

Analysis and Summary of
One "Lessons Learned" Meta-Study*

Basic Findings

- There exists a large body of lessons learned and the "ingredients" for low cost program management are WELL KNOWN!

- These "lessons learned" have been developed and known in various forms for over 30 years (1971 LL Report, 1986 LL Report)

- Interviews with other organizations both within and outside of the government have contributed to this list and validated its content

- The "ingredients" involve all areas of program management including organizational design, management technique, contracting strategy, personnel development and use, funding and schedules management, and so on

- There is a detailed list of lessons learned that should be considered by each area of the program for their applicability and potential implementation

- The combination of these themes and lessons learned can be used as guides for development of a NASA program management implementation plan

* FROM FOX ET. AL.

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Sources of Data*

The data reviewed included the following documents:

— "The Role of Lessons Learned in SEI Management Planning" by Humboldt C. Mandell, Jr.

— "Cost Estimating Issues" by Humboldt C. Mandell, Jr.

— Department of Defense Directive 5000.43: "Acquisition Streamlining" (January 15, 1986)

— Lessons learned from the Polaris Program

— Lessons learned from the ICBM Program

— Lessons learned from the Saturn Corporation

— Lessons learned from the Lockheed skunkworks (observations by Clarence "Kelly" Johnson)

— Lessons learned from the Boeing Company experience relative to shuttle planning

— LMSC program reviews

— "Impediment Study" by Jack O'Brien

— DOD Input to SEI: Program Experience

— Donna Pivirotto interview with Tom Utsman (July 25, 1991)

— "Space Shuttle Directions," Advanced Programs Office, June, 1986

— "Alternative Structures Analysis" by Richard Reeves (1987)

— "Industry Experience as Considered by NASA in Shuttle Program Definition" (1971)

— Report of the Advisory Committee on the Future of the U.S. Space Program

— Packard Commission Report

NOTE: This list is intended to reflect all sources reviewed. However, since much of the data appeared to be "rolled up," summarized, bulletized, or reworded, it is not possible to be sure all sources are noted.

* FROM FOX ET. AL.

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Overriding Lessons Learned
— Theme #1 — (From Fox, et. al.)

The "learning of the lesson learned" is not enough in itself to effect a change. There must be a dedicated effort put forth.

i.e. "…their implementation is culturally and situationally constrained"

"…lessons learned analysis, by itself is not enough"

"…there must be a dedicated…effort to bring about any significant change"

"…change will not happen by itself"

"…obvious mistakes and weaknesses have been repeated"

"…the cultural acceptance of practices…made all but impossible to change"

"…change must be planned"

"…knowing that a problem existed…no indicator it can be avoided in future"

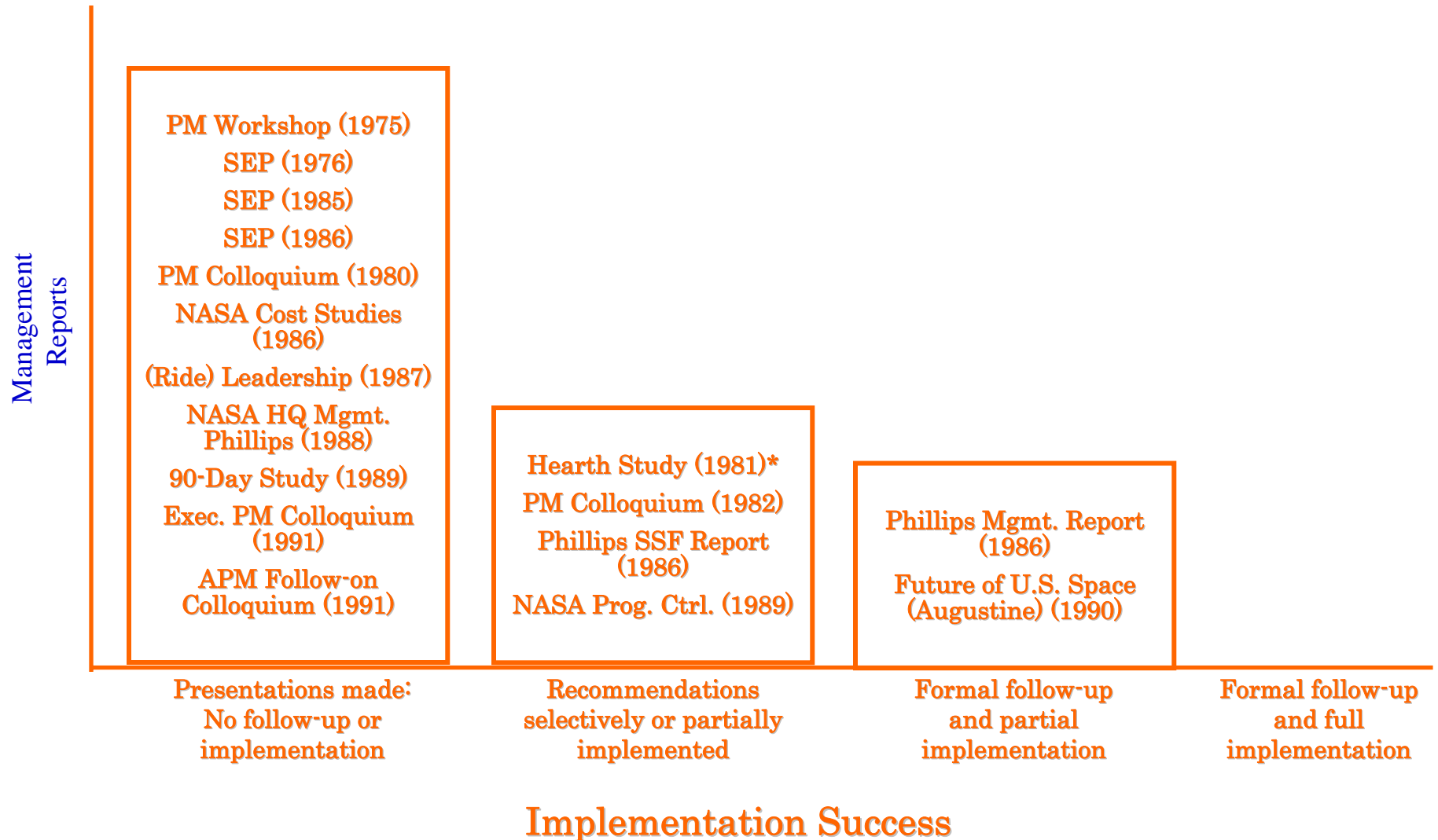"…plan the change; a deliberate process of planning is vital"

Major Findings (Fox, Et. Al.)

Common Issues in the Management of NASA Programs and Projects

Issues	1975 PM Workshops	1978 SEP	1980 PM Colloquium	1981 Hearth Study	1982 PM Colloquium	1985 SEP	1986 SEP	1986 NASA Cost Studies	1986 (Phillips) Review of Space Station	1986 (Phillips) NASA Mgmt. Study Group	1987 P2 Steering Group	1987 (Ride) Leadership	1988 (Phillips) HQ Mgmt. Study	1989 (Cohen) 90-Day Study	1989 (NAPA) Program Control	1990 (Augustine) Future of U.S. Space	1991 Executive PM Colloquium	1991 APM Follow-on	Total
1. Conduct training for program/project management personnel	3		3					3							3		3	3	6
2. Conduct annual meeting of project managers	3																		1
3. Develop realistic cost estimates	3		3					3		3					3		3		6
4. Clarify HQ role in project management	3		3		3				3	3	3					3	3	3	9
5. Improve adequate front-end planning definition	3	3	3	3	3	3		3									3		8
6. Need for long range vision and agency roles										3	3	3	3				3	3	6
7. Conflict between institutional and program needs										3	3		3						3
8. Attention to operations and logistics										3	3			3					3
9. Need for adequate requirement definitions	3	3		3	3	3				3						3			7
10. Contractor and NASA buy-ins		3		3	3										3	3	3	3	7
11. Clarity and communication of mission goals and objectives	3	3		3		3				3		3	3			3	3	3	10
12. Need for communication at all NASA levels and contractor teamwork	3	3	3	3	3	3							3				3	3	9
13. Improve management of contingency funding	3		3	3		3								3		3		3	7
14. Eroding in-house technical expertise	3		3	3							3			3		3	3	3	8
15. Need for risk assessments				3	3	3	3	3					3			3			7
16. Increasing technical complexity of projects				3		3								3	3	3			5
17. Develop formal top-down planning process			3							3		3	3			3	3	3	7
18. Formalize S/E process								3		3			3				3		4
19. Maintain more consistent documentation								3		3			3						3
20. Better manage Congressional issues										3									1
21. Over-commitment			3								3						3	3	4
22. Need to establish improved international involvement									3				3	3	3				4
23. Improve program control function — develop agency models, control to baseline, etc.				3						3			3	3	3			3	6
24. Acquisition reform														3	3			3	3

Information provided by the program/project initiative

Corrective Action History (Fox, et. al.)

Management Reports (vertical axis)

Box 1 — Presentations made:
PM Workshop (1975)
SEP (1976)
SEP (1985)
SEP (1986)
PM Colloquium (1980)
NASA Cost Studies (1986)
(Ride) Leadership (1987)
NASA HQ Mgmt. Phillips (1988)
90-Day Study (1989)
Exec. PM Colloquium (1991)
APM Follow-on Colloquium (1991)

Box 2 — Recommendations:
Hearth Study (1981)*
PM Colloquium (1982)
Phillips SSF Report (1986)
NASA Prog. Ctrl. (1989)

Box 3 — Formal follow-up:
Phillips Mgmt. Report (1986)
Future of U.S. Space (Augustine) (1990)

| Presentations made: No follow-up or implementation | Recommendations selectively or partially implemented | Formal follow-up and partial implementation | Formal follow-up and full implementation |

Implementation Success

* Published 4 years later in NMI 7120.3

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Overriding Lessons Learned*
— Theme #2 —

The way we structure and manage our contracts provides the largest potential leverage for change and management gain within the space cultural paradigm.

i.e. "…keep requirements fixed"

"…specify performance…not how to achieve the results"

"…minimize or eliminate government imposed changes"

"…incentivize the contractor to keep costs low"

"…use contractors existing management systems"

"…use prime as integrating contractor"

"…reduce interaction between NASA and contractors"

"…get out of bed with contractors"

"…explore fee arrangement to place more emphasis on performance"

"…allow…maximum autonomy in deciding on how best to meet government requirements"

"…use competition in the market place"

"…bidding pressures influence the accuracy and risk"

"…over control is a deterrent to good performance"

"…formal PMS employed were largely ineffective"

"…contract definition will never disclose problems…because of competition"

Overriding Lessons Learned*
— Theme #3 —   *Fox, Et. Al

The typical NASA bureaucratic management organization, structure, and style does not promote the efficiency and innovation required for successful management.

i.e. "…minimize government involvement"

"…force people off development programs when development is complete"

"…establish clear understanding of roles, responsibilities, and authority"

"…demand a commitment to excellence…competent dedicated people"

"…provide open communication in all directions"

"…motivate all to succeed"

"…delegate authority with provisions to keep management informed"

"…utilize small, hand picked government program offices…"

"…functions hand off people during peak problem period…"

"…put lots of smart people on a program early and get them off early"

"…appoint people you trust and then don't over-manage them"

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Overriding Lessons Learned
— Theme #3 (Continued)* — ^{*Fox, Et. Al}

"…include all key individuals in major decision areas"

"…authority and responsibility for direct control over all…agencies"

"…flexible organizational structure and management systems…"

"…freedom from traditional government bureaucratic impediments"

"…reduce the number of management levels"

"…work with OPM to explore the further relaxation in flexible hiring"

"…stress delegation of responsibility"

"…performance/reward system provides insufficient rewards…is slow"

"…revamp appraisal process, allowing line managers…flexibility"

"…accountability should be understood and accepted"

"…responsibility should be clear and unambiguous"

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Overriding Lessons Learned*
— Theme #4 —

Programs should only begin when there is a balance between technical content and readiness, schedules, and budget availability and support.

i.e. "...ensure all technologies are proven prior to the end of competition"

"...don't start a program until cost estimates and budget available match"

"...defer...flight hardware construction until...technological uncertainties are resolved"

"...peak funding availability is...most significant single factor"

"...realistic...budgets...must be set to avoid wasted management energy"

"...program content and capability must be consistent with expected budgets"

"...cost studies show...largest...cause of...cost overrun is premature starts"

THE "COMMANDMENTS"
## A Summary of Lessons Learned From Previous
NASA Management Studies

- The ingredients of successful low-cost, high technology programs are well known and universally recommended by the many successful program managers interviewed
  — Government (NASA) should only define and verify requirements
  — Define Requirements in terms of PERFORMANCE. Then Keep Them fixed: once requirements are stated, only relax them; never add new ones
  — Specify end results (performance) of products, not how to achieve the results
  — Place product responsibility in a competitive private sector
  — Minimize government involvement (small program offices)
  — Insure that all technologies are proven prior to the end of competition
  — Utilize the private sector reporting system: reduce or eliminate specific government reports
  — Don't start a program until cost estimates and budget availability match
  — Minimize or eliminate government imposed changes
  — Reduce development time: any program development can be accomplished in 3 to 5 years once uncertainties are resolved
  — Force people off of programs when development is complete
  — Incentivize contractors to keep costs low (as opposed to CPAF, CPFF of NASA). Reward only product performance.
  — Use geographic proximity of contractor organizations when possible (e.g., concurrent engineering)
  — To reduce the number of interfaces and keep responsibilities clean, use the major prime contractor as the program integrator

NASA has known these principles for many years.
Implementation has almost never succeeded

FOR SPACE RESEARCH
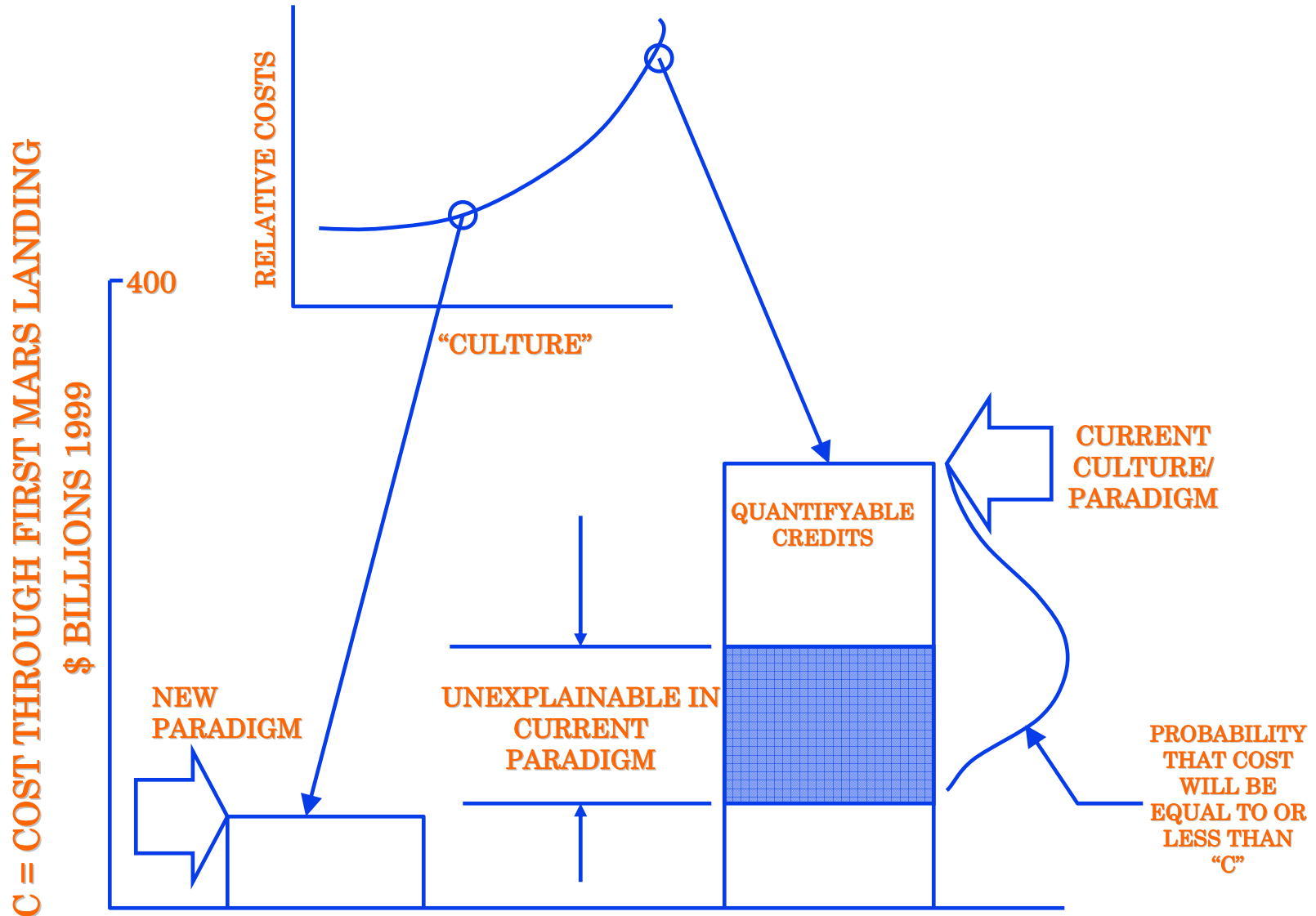
Effect of Development Organization Type on Program Development and Production Cost*
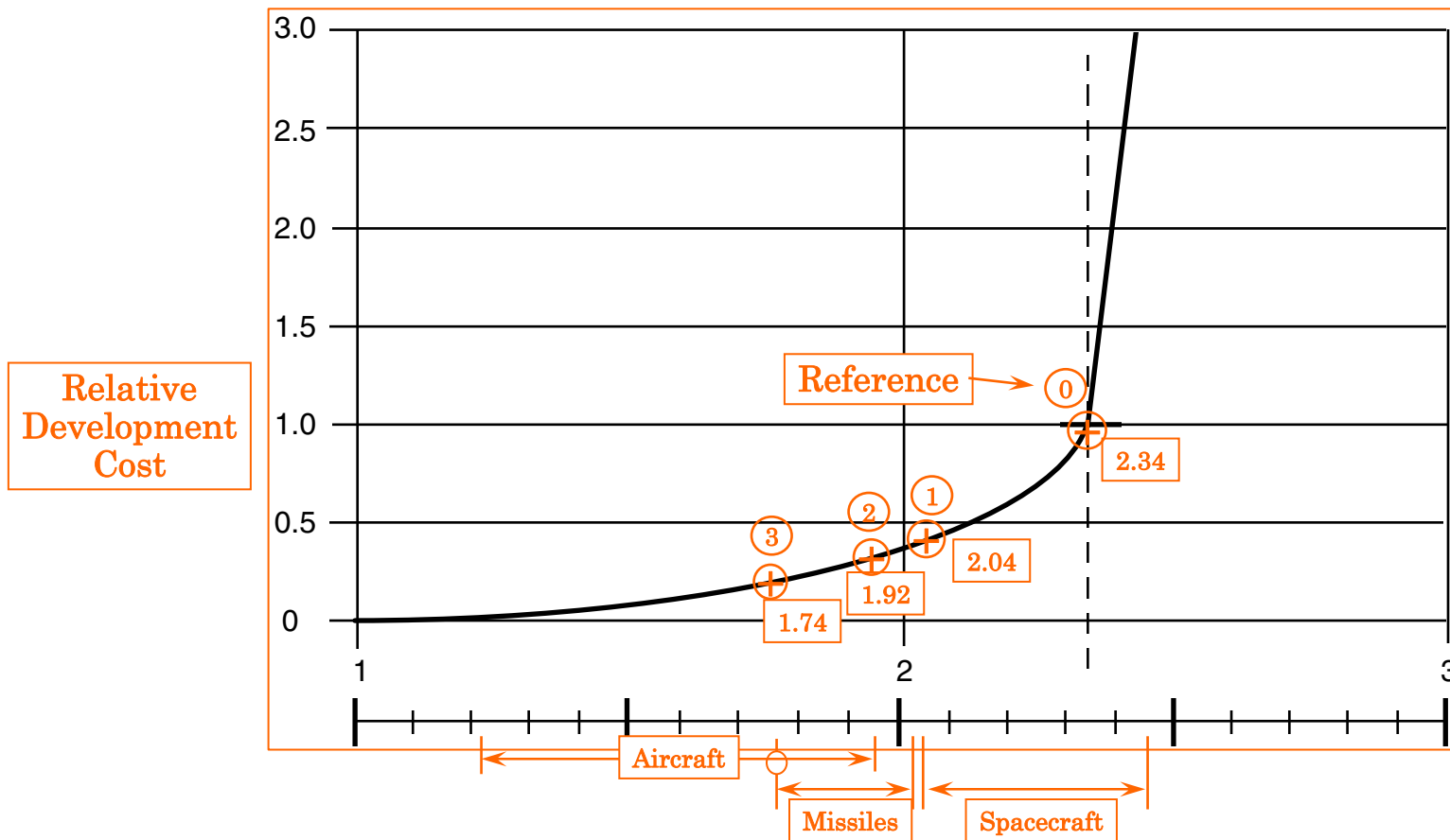
Small changes in development management style can have huge influences on the costs of space programs

MUCH OF THE AVAILABLE COST
SAVINGS MAY NOT BE QUANTIFYABLE

RELATIVE COSTS

C = COST THROUGH FIRST MARS LANDING
$ BILLIONS 1999

400

"CULTURE"

NEW
PARADIGM

UNEXPLAINABLE IN
CURRENT
PARADIGM

QUANTIFYABLE
CREDITS

CURRENT
CULTURE/
PARADIGM

PROBABILITY
THAT COST
WILL BE
EQUAL TO OR
LESS THAN
"C"

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Can Changes Be Made?

Case Study
Space Industries, Inc.
(Work by Whitlock, et. al.)

Process: Comparative Cost Analysis

Benchmarking of actual space hardware development

— Technical characteristics of hardware

— Management process

— Customer interfaces

— Costs

— Schedules

Ran S.I.I. data in NASA cost models

Results: S.I.I. flight products cost 1/6 to 1/10 of NASA cost model predictions

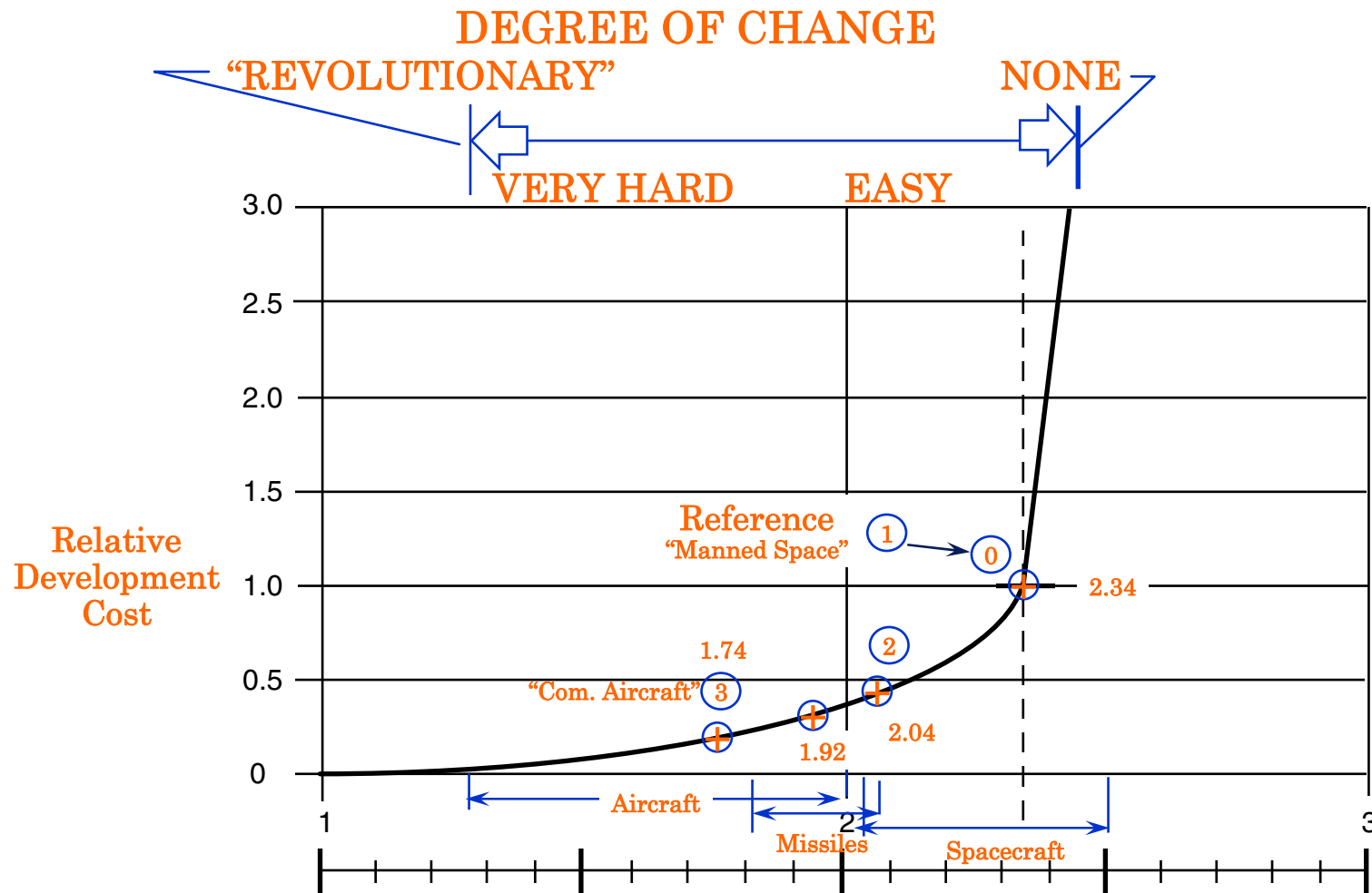Other similar efforts by MSFC showed similar results.

> Major cost reductions are not only possible, they are being demonstrated

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DIFFICULTY OF MAKING CULTURAL CHANGES*

*Based on Research by Kelley Cyr

Even small changes in development management style can be very difficult to implement

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Why Hasn't Change Happened?

- Established NASA Culture: Resistant to change (with good reason?)

- Independent Team Recommendations: Lack of ownership by those who have to do the job

- Lack of Implementation Mandate: No accountability, and follow-up

- Lack of Cost Containment Incentive: Managers' incentives and reward systems do not really get changed

- Lack of Threat: Change rarely occurs without perceived threat throughout the system

- SOP's: Good intentions, but without planned change, we fall back on standard operation procedures

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WHAT CAN BE DONE

- The Management Plan for the Space Exploration Initiative Incorporated MANY Lessons Learned
- The "Commandments" were closely followed
- Exhaustive management studies by Richard Reeves and others developed the most likely structure to succeed
  - Core Team of "New Culture" People
  - Geographically separated from "Old Culture"
  - Marketplace Incentives
  - Etc (See "Commandments")
- Many of the Concepts Proposed in the Early 1990's are still valid

MOON/MARS MANAGEMENT TEAM
SEPTEMBER 16, 1996 FINDINGS

- NASA INSTITUTIONAL REFORM:
  - ADOPT ADMINISTRATOR'S "VISION" FOR MANAGEMENT REFORM
    - LIMITED ROLE OF NASA, SMALL PROJECT OFFICES
    - NASA IS "HIGH-LEVEL ARCHITECT"
    - GOVERNMENT ROLE IS TO PROTECT INTERESTS OF TAXPAYERS
    - MAXIMUM USE OF PRIVATE SECTOR, COMMERCIAL PRODUCTS
  - FIND THE BEST MANAGEMENT INSTITUTIONAL FORM (E.G., FFRDC, SPACE-ACT REFORMS, DIFFERENT REPORTING STRUCTURES IN NASA, ETC.)
  - ADOPT CONTRACTING/ACQUISITION REFORM
    - MODIFY CONTRACTOR INCENTIVES TO DISCOURAGE COST GROWTH, ENCOURAGE PRODUCT PERFORMANCE
    - SELECT CONTRACTORS WHO HAVE ALL NEEDED SKILLS, LONG TERM PERSPECTIVE (VS. BEST PROPOSAL WRITERS, QUICK PROFIT MOTIVE)
  - PROGRAM MANAGEMENT REFORMS
    - STUDY AND ADAPT FEATURES OF SIMPLER DEVELOPMENT PARADIGMS (E.G., SKUNK WORKS, OSC, SII, RUSSIAN)
    - KEEP CLEAN SEPARATION OF GOVERNMENT AND CONTRACTOR FUNCTIONS
    - USE GOVERNMENT EXPERTISE ONLY WHERE IT IS NOT AVAILABLE IN THE PRIVATE SECTOR
    - *ALLOW NO NASA PARTICIPATION IN THE CHANGE PROCESS*

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MOON/MARS MANAGEMENT TEAM
SEPTEMBER 16, '96 FINDINGS, CONCLUDED

- **NASA PROGRAM DESIGN PROCESS:**
  - DO NOT COMPROMISE CLEAN INTERFACES FOR INSTITUTIONAL EXPEDIENCY
  - KEEP DEVELOPMENT TIMES AS SHORT AS POSSIBLE (5 YEARS OR LESS)
  - INSURE THAT ADEQUATE RESOURCES ARE AVAILABLE BEFORE COMMITMENT
  - DESIGN THE PROGRAM TO THE AVAILABLE BUDGET WEDGE, AND INCLUDE AMPLE RESERVES
  - WORK SCHEDULE AND COST TOGETHER. DON'T COMPROMISE SHORT SCHEDULE TO LOWER ANNUAL COSTS

- **STRATEGIC ISSUES:**
  - INSURE COMPATIBILITY WITH HEDS ENTERPRISE, HQ "FRAMEWORK" AND "IMPEDIMENTS" STUDIES
  - IMPLEMENT "NEW PARADIGM" MANAGEMENT METHODS IN NEW AND ONGOING PROGRAMS QUICKLY TO DEMONSTRATE THEIR UTILITY ("QUICK WIN'S")
  - THE CHANGE "RECIPE" CAN BE WRITTEN, "COMMANDMENTS" ARE KNOWN, BUT ALL MUST BE SOLD TO NASA MANAGEMENT
  - INSTITUTIONAL INTERESTS CAN NOT BE IGNORED. WIN-WIN STRATEGIES MUST BE FOUND WHICH INCENTIVIZE NASA CENTERS TO ACCEPT MAJOR CHANGE (CURRENT CENTER ACCEPTANCE OF NEED FOR MAJOR CHANGE IS NOT UNIVERSAL).
  - EXPLORE CIVIL SERVICE REFORMS TO CHANGE THE REWARD SYSTEM
  - BETTER DEVELOP THE RATIONALE FOR HUMAN SPACE EXPLORATION

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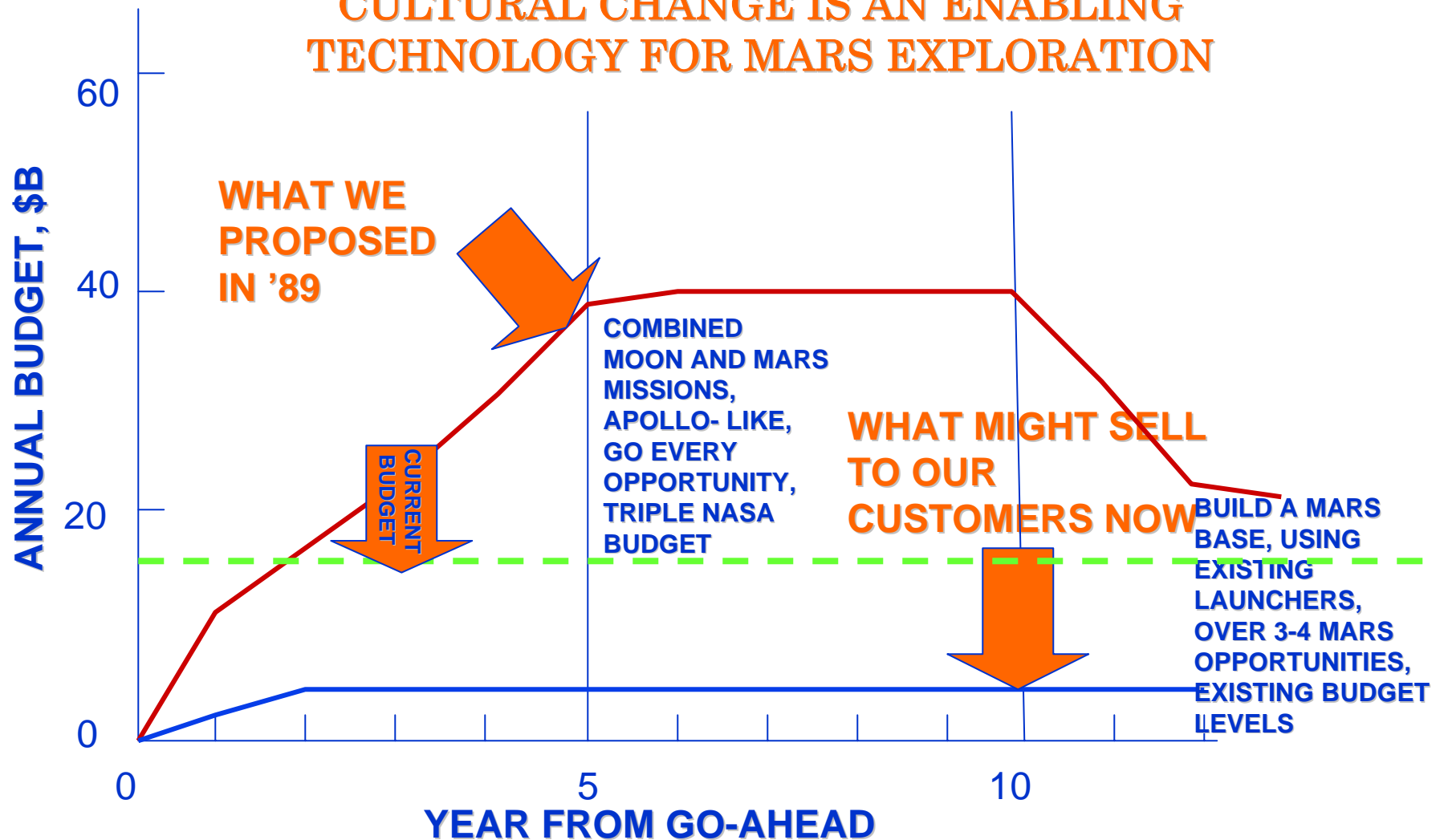
EXAMPLE OF HARD-WON LESSONS LOST

- Senior Inter-Center task force led by Larry Ross studied the NASA Handbooks for Management (NHB 7120, ..)

- Recommendations Included Giving Program Managers Discretion on Program Phases

- Recommended Doing Away With Imprecise Terms Like Phase A, Phase B, . . .
  – These terms were widely used, but had little standardization
  – With modern design technology, a Phase A could be done in a few days, a Phase B likewise (e.g., JPL Team X)
  – Terms were therefore ambiguous and overly-constraining

- Incorporated into a revision of the NHB, which took years to get approved

- Recent editions have reversed that hard-fought victory (the old culture won)
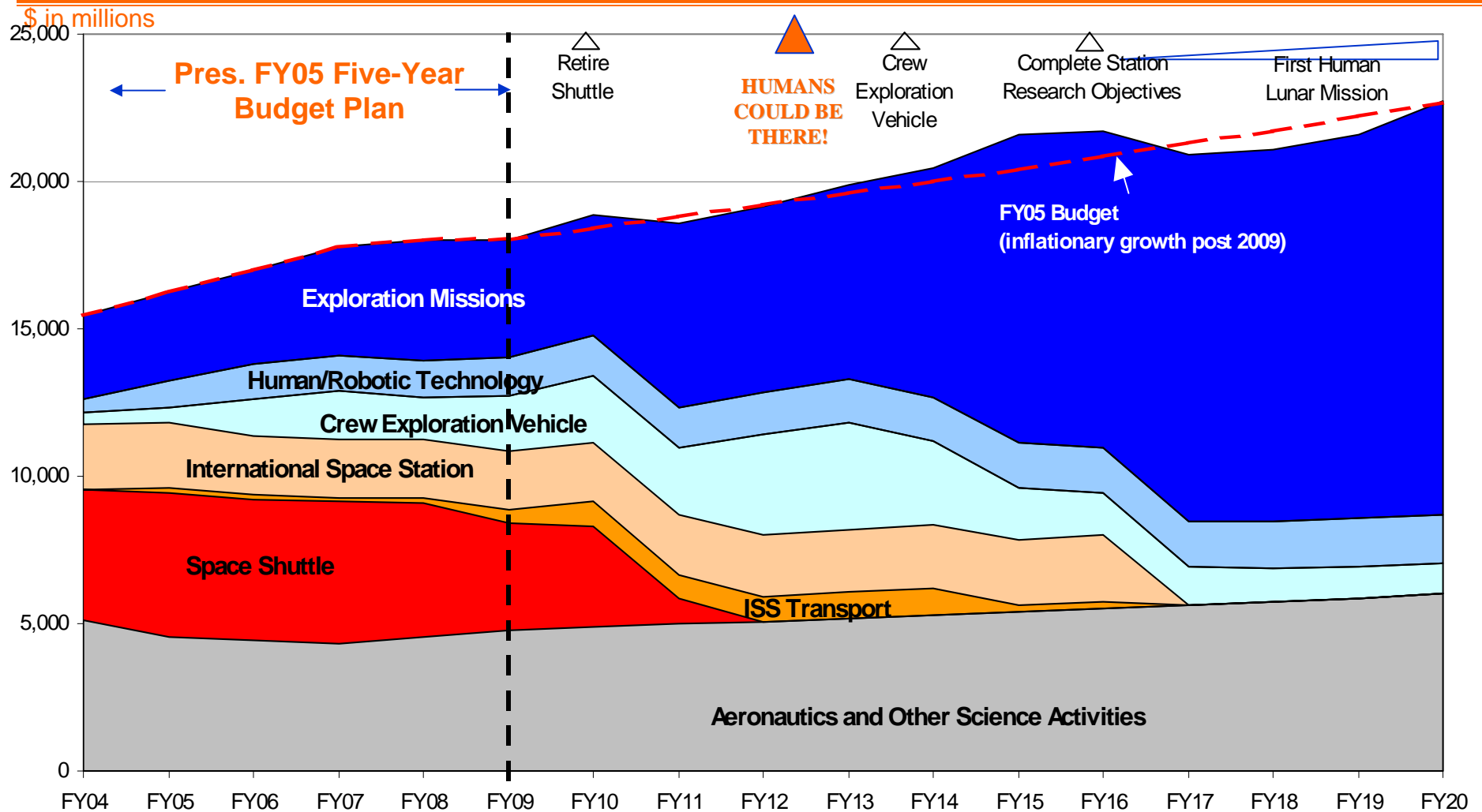
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IS IT WORTH THE EFFORT?

CULTURAL CHANGE IS AN ENABLING TECHNOLOGY FOR MARS EXPLORATION

WHAT WE PROPOSED IN '89

CURRENT BUDGET

COMBINED MOON AND MARS MISSIONS, APOLLO- LIKE, GO EVERY OPPORTUNITY, TRIPLE NASA BUDGET

WHAT MIGHT SELL TO OUR CUSTOMERS NOW

BUILD A MARS BASE, USING EXISTING LAUNCHERS, OVER 3-4 MARS OPPORTUNITIES, EXISTING BUDGET LEVELS

ANNUAL BUDGET, $B

60

40

20

0

0   5   10

YEAR FROM GO-AHEAD

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The President's Budget Strategy

NOTE: Exploration missions – Robotic and eventual human missions to Moon, Mars, and beyond
Human/Robotic Technology – Technologies to enable development of exploration space systems
Crew Exploration Vehicle – Transportation vehicle for human explorers
ISS Transport – US and foreign launch systems to support Space Station needs especially after Shuttle retirement

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Perception of Change

"Nothing is more difficult to undertake, more perilous to conduct or more uncertain in its outcome, than to take the lead in introducing a new order of things. For the innovator has for enemies all those who have done well under the old and lukewarm defenders amongst those who may do well under the new."

Machiavelli

"If you do what you've always done you'll get what you always got."

W. Edwards Deming

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